BEET SUGAR SUPPLY RESPONSE IN THE UNITED STATES

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ABSTRACT

Projections of U.S. sugarbeet acreage are made under alternative prices for raw sugar and for major crops that compete with beets by using an econometric model of the sugarbeet production sector. Raw sugar prices (New York spot) of about 16 to 22 cents per pound will probably be needed to maintain the 1976 sugarbeet acreage in 1980. Significant regional shifts in the location of production are likely, regardless of future sugar prices.

Key Words: Acreage, production, projections, sugar, sugar beets, supply function.

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SUMMARY

Crop year average raw sugar prices (New York spot) of about 16 to 22 cents per pound will likely be needed between 1976 and 1979 to maintain U.S. sugarbeet acreage near the 1976 level. The exact level required for stability in acreage will depend greatly on prices for competing crops, mainly feed grains, wheat, soybeans, and alfalfa. If prices for these crops remain at records set in 1973-75, there is little doubt that a continuation of recent raw sugar prices (9 to 15 cents since mid-1976) will result in substantial cutbacks in sugarbeet plantings.

Even with stability in aggregate U.S. acreage, pronounced regional shifts in the location of sugarbeet production are likely to occur. Partly because of the heavy incidence of grower ownership of processing facilities in the Red River Valley, this region is projected to exhibit little shortrun change in acreage planting. In contrast, the West (California-Arizona), Northern Plains, and Southern Plains probably will rapidly adjust their acreage with low sugar prices, particularly if feed grain and soybean prices are high. The Intermountain region of Idaho and Utah is projected to decrease its acreage from the 1976 level, even with relatively high sugar prices, and it would likely cease beet production by 1980 if raw prices are less than 15 cents per pound.

These conclusions are based on projections made by using an econometric model of the U.S. sugarbeet production sector. Using regional designations of the Agricultural Stabilization and Conservation Service, equations were defined and estimated for planted and harvested acreage, sugarbeet and refined beet sugar production, and grower return per ton of beets as a function of the New York spot raw sugar prices. The planted acreage equations used lagged acreage, the lagged ratio of beet returns of unit returns for major competing crops, and regional beet slicing capacity as major explanatory variables.

Projections assume factory capacities that match 1976 levels, extraction rates and regional sucrose percentages equivalent to recent ones, and no U.S. price support program for beets. High, medium, and low price trends for competing crops were considered, based on 1954-75 experiences.

The projections must be viewed cautiously because of certain limitations of the study. Probably the most important was the period used for estimation, 1954-74, during which the expired U.S. Sugar Act was in effect. Its expiration undoubtedly affected growers' decisions concerning resource allocation among beets and alternative crops. The nature and extent of this structural change cannot yet be assessed. Record high farm prices for crops competing with sugar beets may have further altered the growers' decision-making process. Finally, the analysis does not consider processor decisions concerning factory expansion or contraction or how the increased post-Sugar Act price uncertainty has affected these decisions.

CANE SUGAR SUPPLY RESPONSE IN THE UNITED STATES

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INTRODUCTION

Per capita consumption of sugar in the United States is about 100 pounds annually [10].1/ Two-thirds of this is consumed in the form of manufactured foods such as beverages, baked goods, candies, and ice cream. The remainder is used on the table or in kitchen preparation of foods. Twenty-two percent of total U.S. sugar consumption was from domestically produced sugarcane in 1975 (table 1).

Table 1--Sugar deliveries for the continental United States, by source of supply, 1975

Source of supply	Raw value of sugar 1/
	Million hundredweight
Domestic beet sugar	65.1
Domestic cane sugar	56.2
Imported sugar	77.5
Total	198.7

1/ Raw value is a computed quantity of sugar meaning its equivalent in terms of ordinary commercial raw sugar testing 96 percent pure.
Source: Estimated from [10].

Federal sugar legislation has had an important effect on domestic sugar production in the past. In return for so-called "conditional payments," producers were obligated, among other things, to conform to any limitations on production imposed by the U.S. Secretary of Agriculture. The imposition of production limitations was needed to ensure the proper functioning of a marketing quota system provided for by the Sugar Act of 1948, as amended [5]. The system of production controls tended to make sugar supply response an administrative and/or political decision as well as an economic decision. Some growers who may have wanted to expand sugar production could be restrained by their proportionate share quota. Other producers could continue sugar production

1/ Sugar may be any one of a chemical family of carbohydrates used in the kitchen and in food processing. One member of this family, sucrose ($C_6H_{12}O_6$), is the product popularly called sugar. It is manufactured primarily from sugarcane and sugar beets.

regional acreage response relationships are presented. Finally, regional and aggregate beet sugar production totals are forecast under several assumptions with respect to sugar prices and prices for competing crops.

STRUCTURE OF THE BEET SUGAR INDUSTRY

During the past 20 years, refined beet sugar produced domestically has supplied 20 to 30 percent of total caloric sweetener consumption in the United States. The remaining total supply has come from domestic cane sugar (15 to 30 percent), imported cane sugar (30 to 45 percent), corn sweeteners (10 to 20 percent), and such minor caloric sweeteners as honey and maple syrup (1 to 2 percent). Production of refined beet sugar ranged from 2.2 to 4 million tons during 1960-75 (1).

Characteristics of Growers and Processors

Sugarbeets are grown in 20 States, mainly west of the Mississippi River. The ASCS categorizes production into eight regions sharing similar production practices and costs (8). These regional groupings, sugarbeet-producing counties, and operating factories are identified in figure 1.

Tables 1-3 summarize selected structural characteristics by region. Table 1 shows changes during the past 10 years in grower numbers operation, sizes, and production measures. Table 2 illustrates trends in processor numbers and operation sizes. Table 3 demonstrates the importance of beets in overall farm plans and shows the relative importance of other crops that compete with beets for resources.

Region 1--East 4/

ASCS region 1 includes all sugarbeet production east of the Mississippi River. Although several Eastern States grew beets at one time, production in 1976 was limited to northwest Ohio and southwest Michigan. 5/

Sugarbeet acreage is nonirrigated in both States. In Ohio the major competing crops are alfalfa, corn, oats, soybeans, and wheat. Dry beans compete with beets for acreage and other resources in Michigan along with corn, soybeans, and wheat. Typical producers in the region are small relative to other regions; average beet acreage per farm is about half the national acreage.

Beet processors in region 1 are also relatively small (table 2), ranging in daily slicing capacity from 1,600 to 4,000 tons. Four firms operated eight factories in 1975. Processors in Michigan are the Michigan Sugar Company (four factories) and the Monitor Sugar Company (one factory). Buckeye Sugars, Inc. (one factory), and Northern Ohio Sugar Company (two factories) operate in Ohio.

4/ For a more extensive discussion of specific characteristics of sugarbeet producing regions, see (6).

5/ In addition, 10,000 acres were planted in Aroostook County, Maine, in 1976.

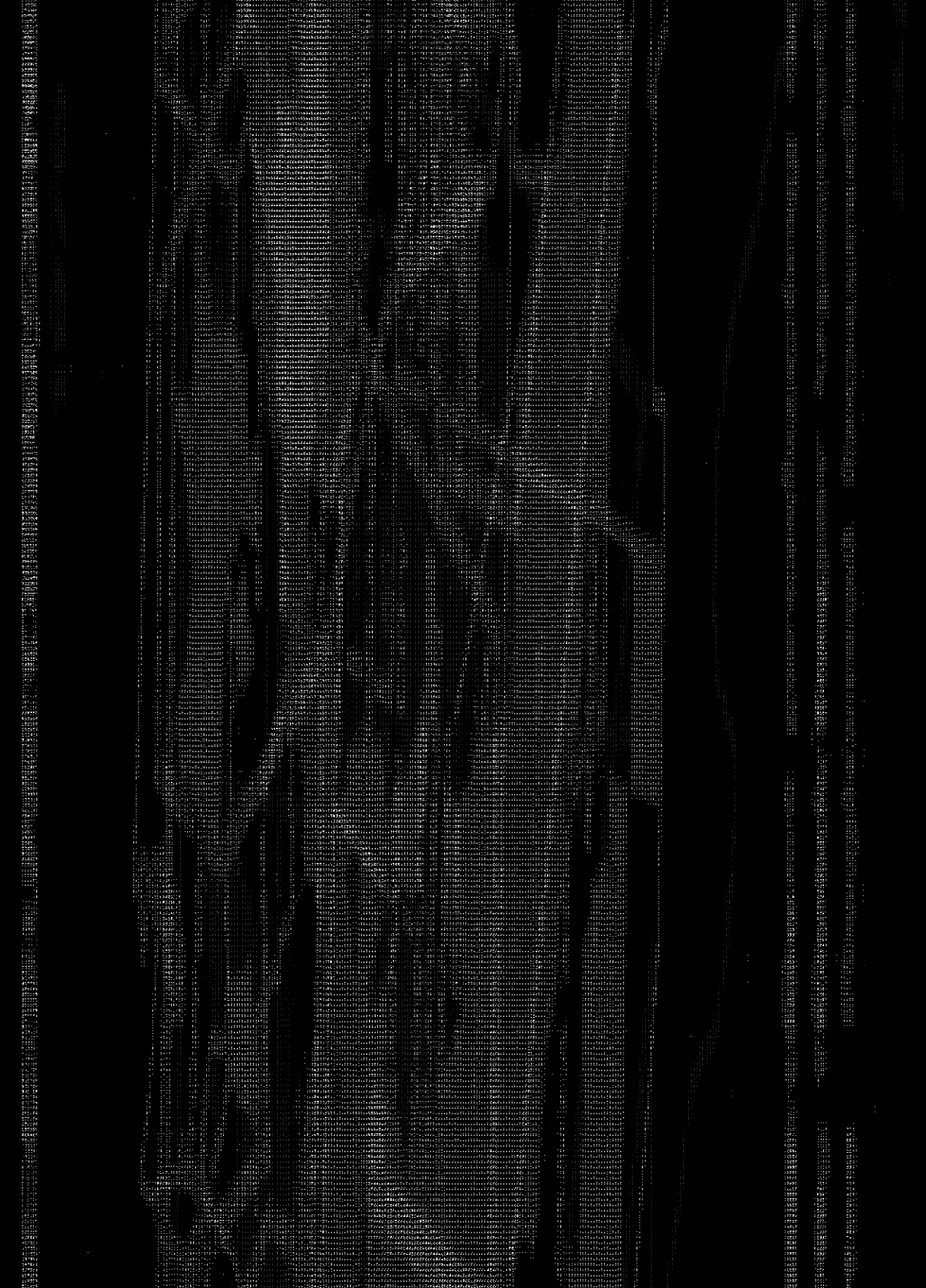


Table 1--Selected characteristics of sugarbeet-producing regions, 1961-63 and 1971-73 averages

Item and unit	ASCS regions								U.S. total or average
	1 East	2 Red River Valley	3 North Plains	4 South Plains	5 Montana-Wyoming	6 Inter-mountain	7 North-west	8 Far West	
Number of farms growing sugarbeets									
1961-63	4,172	1,636	5,716	795	1,899	3,604	3,203	2,300	23,325
1971-73	2,767	1,537	2,831	459	1,133	1,933	1,879	1,472	14,008
Percentage change	-33.7	-6.1	-50.5	-42.6	-40.3	-46.4	-70.5	-36.0	-39.9
Harvested area, 1,000 acres									
1961-63	101	153	254	41	102	115	116	265	1,147
1971-73	120	186	236	46	95	138	152	319	1,292
Percentage change	+18.8	+21.6	-7.2	+12.2	-6.8	+20.0	+31.0	+20.4	+12.6
Average area per farm, acres									
1961-63	26	97	48	56	56	33	37	121	49
1971-73	43	121	83	101	84	71	81	217	92
Percentage change	+63.7	+24.6	+72.9	+80.4	+50.0	+115.2	+118.9	+79.3	+87.8
Yield per acre, tons of beets									
1961-63	15.6	12.0	15.9	15.8	15.0	17.1	25.5	19.8	17.3
1971-73	17.9	15.3	18.5	20.0	19.3	18.0	25.7	25.4	20.6
Percentage change	+15.0	+27.5	+16.3	+26.6	+28.7	+5.3	+0.8	+28.3	+19.1
Average sugar content of beets, percent									
1961-63	15.1	15.2	15.8	15.0	15.9	15.8	14.8	14.2	15.1
1971-73	15.3	15.0	16.2	14.5	16.2	16.0	15.5	15.0	15.4
Percentage change	+1.3	+1.3	+2.5	-3.3	+1.9	+1.3	+4.7	+5.6	+2.0
Grower return per ton, dollars 1/									
1961-63	11.80	11.60	12.70	11.50	12.50	12.50	11.60	11.90	12.00
1971-73	18.70	19.00	23.20	20.20	22.70	22.90	22.00	20.20	21.10
Percentage change	+58.5	+63.8	+82.7	+75.6	+81.6	+83.2	+89.7	+69.7	+75.8

1/ Does not include Government payments under the U.S. Sugar Act.

Source: Sugar Division, ASCS. Some regional figures that were derived from State data are estimates.

Table 2--Number of factories processing sugarbeets and their daily slicing capacity by region 1/

Crop year beginning in--	ASCS region: 1--East			2--Red River Valley			3--Northern Plains		
	Factories	Daily slicing capacity: Total	Daily slicing capacity: Average	Factories	Daily slicing capacity: Total	Daily slicing capacity: Average	Factories	Daily slicing capacity: Total	Daily slicing capacity: Average
	No.	1,000 tons		No.	1,000 tons		No.	1,000 tons	
1955	9	12.25	1.36	5	12.10	2.42	16	31.80	1.99
1956	9	12.25	1.36	5	12.50	2.50	16	31.90	1.99
1957	9	12.55	1.39	5	12.70	2.54	16	31.90	1.99
1958	9	12.75	1.42	5	13.35	2.67	16	32.55	2.03
1959	9	12.75	1.42	5	13.35	2.67	16	32.55	2.03
1960	9	13.15	1.46	5	14.05	2.81	16	32.55	2.03
1961	9	13.14	1.46	5	14.05	2.81	16	32.55	2.03
1962	8	14.10	1.76	5	14.50	2.90	16	34.30	2.14
1963	8	14.30	1.79	5	14.85	2.97	16	34.30	2.14
1964	8	14.30	1.79	5	14.85	2.97	16	34.30	2.14
1965	9	19.20	2.13	6	20.20	3.37	14	31.30	2.24
1966	10	23.30	2.33	6	20.20	3.37	14	33.90	2.42
1967	10	23.30	2.33	6	20.20	3.37	13	32.20	2.48
1968	9	19.90	2.21	6	20.20	3.37	14	36.21	2.59
1969	9	19.90	2.21	6	20.20	3.37	14	36.21	2.59
1970	8	17.08	2.14	6	20.90	3.50	14	36.64	2.62
1971	8	17.08	2.14	5	18.80	3.76	14	36.64	2.62
1972	8	17.08	2.14	4	16.40	4.10	14	36.64	2.62
1973	8	17.08	2.14	4	16.40	4.10	14	36.64	2.62
1974	8	18.70	2.34	6	26.70	4.45	14	37.95	2.71
1975	8	18.70	2.34	7	32.70	4.67	14	37.95	2.71

Crop year beginning in--	ASCS region: 4--Southern Plains			5--Montana-Wyoming			6--Intermountain		
	Factories	Daily slicing capacity: Total	Daily slicing capacity: Average	Factories	Daily slicing capacity: Total	Daily slicing capacity: Average	Factories	Daily slicing capacity: Total	Daily slicing capacity: Average
	No.	1,000 tons		No.	1,000 tons		No.	1,000 tons	
1955	4	7.00	1.75	6	11.30	1.88	9	17.35	1.93
1956	4	7.00	1.75	6	11.60	1.93	8	17.08	2.14
1957	4	7.00	1.75	6	11.60	1.93	8	17.45	2.18
1958	4	7.30	1.83	6	12.20	2.03	9	19.70	2.19
1959	3	5.10	1.70	6	12.20	2.03	8	18.50	2.31
1960	3	5.40	1.80	6	12.25	2.04	8	18.95	2.37
1961	3	5.40	1.80	6	12.25	2.04	7	17.30	2.47
1962	3	6.00	2.00	6	12.70	2.12	7	17.22	2.46
1963	3	6.10	2.03	6	12.95	2.16	6	15.89	2.65
1964	4	12.10	3.03	6	12.95	2.16	6	15.89	2.65
1965	4	10.80	2.70	6	12.95	2.16	6	16.10	2.68
1966	4	12.10	3.03	5	11.60	2.32	6	21.15	3.53
1967	3	10.90	3.63	5	11.90	2.38	6	21.15	3.53
1968	3	11.50	3.83	5	12.92	2.58	6	22.45	3.74
1969	3	11.50	3.83	5	12.02	2.58	6	22.45	3.74
1970	3	11.70	3.90	5	13.22	2.64	6	22.55	3.76
1971	3	11.70	3.90	4	11.32	2.83	6	20.85	3.48
1972	3	11.70	3.90	4	11.32	2.83	4	18.90	4.73
1973	3	11.70	3.90	4	11.32	2.83	4	18.90	4.73
1974	3	11.60	3.87	4	12.40	3.10	4	17.85	4.46
1975	3	11.60	3.87	4	12.40	3.10	4	17.85	4.46

See footnote at the end of table.

Continued

Table 2--Number of factories processing sugarbeets and their daily slicing capacity by region 1/--continued

Crop year beginning in--	ASCS region								
	7--Northwest			8--Far West			U.S. total		
	Factories	Daily slicing capacity		Factories	Daily slicing capacity		Factories	Daily slicing capacity	
		Total	Average		Total	Average		Total	Average
	No.	1,000 tons		No.	1,000 tons		No.	1,000 tons	
1955	4	13.70	3.43	11	29.70	2.70	64	135.20	2.11
1956	4	14.70	3.68	11	30.30	2.75	63	137.32	2.18
1957	4	14.95	3.74	11	30.50	2.77	63	138.65	2.20
1958	4	15.55	3.89	11	32.35	2.94	64	145.75	2.28
1959	4	15.55	3.89	10	29.35	2.94	61	139.30	2.28
1960	4	16.45	4.11	10	30.35	3.04	61	143.15	2.35
1961	4	16.45	4.11	10	30.35	3.04	60	141.50	2.36
1962	4	18.88	4.72	10	34.40	3.44	59	152.10	3.58
1963	4	21.06	5.27	11	39.60	3.60	59	159.04	2.70
1964	4	21.06	5.27	11	39.62	3.60	60	165.04	2.75
1965	4	21.36	5.34	11	40.05	3.64	60	171.96	2.87
1966	4	21.62	5.41	12	44.30	3.69	61	188.18	3.08
1967	4	21.88	5.47	12	44.50	3.71	59	186.02	3.15
1968	4	22.02	5.51	11	43.90	3.99	58	189.10	3.26
1969	4	22.02	5.51	11	43.90	3.99	58	189.10	3.26
1970	4	26.58	6.65	11	44.30	4.03	57	192.96	3.39
1971	4	26.58	6.65	11	44.30	4.03	54	187.26	3.47
1972	4	26.58	6.65	11	44.30	4.03	53	185.31	3.50
1973	4	26.58	6.65	11	44.30	4.03	52	182.90	3.52
1974	4	30.28	7.57	11	46.10	4.19	54	201.58	3.73
1975	4	30.28	7.57	11	46.10	4.19	55	207.58	3.77

1/ Regional production may not necessarily be processed by plants in the same region.

Source: Calculated from ASCS records and from information provided by the U.S. Beet Sugar Association (7). Estimated for years in which data are not available.

Table 3--Competing crops grown on farms producing sugarbeets, 1972 1/

ASCS region	1971-73 area	Competing crops on representative farms		
		Crop 2/	Planted area	Percentage of total
	1,000 acres		Acres	Percent
1--East	120	Sugar beets	79.5	20.3
		Corn	106.0	27.0
		Dry beans	105.4	26.9
		Soybeans	38.6	9.8
		Wheat	31.6	8.1
		Other crops (7)	30.8	7.9
		Total	391.9	100.0
2--Red River Valley	186	Sugar beets	133.1	18.0
		Wheat	323.7	43.8
		Barley	158.9	21.5
		Other crops (10)	124.0	16.7
		Total	739.7	100.0
3-- Northern Plains	236	Sugar beets	149.3	31.0
		Corn	119.7	24.9
		Wheat	110.5	23.0
		Soybeans	41.4	8.6
		Alfalfa	26.7	5.6
		Other crops (8)	33.6	6.9
		Total	481.2	100.0
4 --Southern Plains	46	Sugar beets	84.5	16.9
		Corn	135.9	27.2
		Milo	135.1	27.1
		Alfalfa and other hay	55.2	11.0
		Wheat	50.8	10.2
		Cotton	23.4	4.7
		Other crops (5)	14.3	2.9
		Total	499.2	100.0
5--Montana-Wyoming	95	Sugar beets	115.6	34.1
		Barley	75.4	22.2
		Alfalfa	62.1	18.3
		Corn	47.2	13.9
		Other crops (4)	39.2	11.5
		Total	339.5	100.00

See footnotes at end of table.

Continued

Table 3--Competing crops grown on farms producing sugarbeets, 1972 1/ --Continued

ASCS region	1971-73 area	Competing crops on representative farms		
		Crop 2/	Planted area	Percentage of total
	1,000 acres		Acres	Percent
6--Intermountain	138	Sugar beets	171.3	33.5
		Wheat	105.8	20.7
		Barley	98.4	19.2
		Potatoes	30.4	6.0
		Alfalfa	24.4	4.8
		Other hay	29.7	5.8
		Other crops (4)	51.6	10.0
		Total	511.6	100.0
7--Northwest	152	Sugar beets	130.2	31.7
		Corn	71.0	17.3
		Alfalfa	42.7	10.4
		Potatoes	40.1	9.8
		Wheat	37.3	9.1
		Mint	21.1	5.1
		Soybeans	18.7	4.5
		Other crops (15)	49.8	12.1
		Total	410.9	100.0
8--Far West	319	Sugar beets	416.2	22.3
		Alfalfa	348.8	18.7
		Cotton	262.5	14.0
		Wheat	167.4	9.0
		Barley	162.8	8.7
		Corn	107.1	5.7
		Milo	94.6	5.1
		Other crops (25)	307.9	16.5
		Total	1,867.3	100.0

1/ Based on 1972 ASCS sample survey.
2/ Numbers in parentheses following other crops indicate the total number of other crops reported to be grown on farms producing sugarbeets.

Region 2--Red River Valley

Sugarbeet production in region 2 is concentrated in the Red River Valley near the North Dakota-Minnesota border with some production in southern Minnesota and northern Iowa. Almost all beets are nonirrigated. The far northern latitude limits the number of feasible alternative crops to such major competitors as feed grains, wheat, sunflowers, and potatoes.

Harvested acreage in region 2 expanded by 22 percent between 1961-63 and 1971-73 (table 1). This growth reflected acreage declines in southern Minnesota, Iowa, and South Dakota and large acreage increases in the Red River Valley. Beet yields increased substantially, but they remain well below the national average. Farm numbers in the region exhibited only a small drop during the last decade, but the planted acreage per farm increased by 25 percent.

Beet processing in region 2 is unique in that grower cooperatives control all factories. The American Crystal Cooperative, operating four factories in the Red River Valley, was formed by purchase of a private company, the American Crystal Sugar Company. In the past 2 years three additional cooperatives, all operating single factories, were formed--Southern Minnesota Beet Sugar Corporation, Minn-Dak Farmers Corporation, and Red River Valley Corporation, Inc. Strong grower interest in sugarbeet processing suggests growers' planting decisions might be quite different from those selling to private firms.

Region 3--Northern Plains

Region 3 includes sugarbeet production from eastern Wyoming, Nebraska, northwestern Kansas, and northeastern Colorado. It is the largest region in terms of number of growers and second largest in terms of harvested acreage (1971-73). Elevations are high and rainfall low. All beets are irrigated. Major competing crops are corn, wheat, soybeans, and alfalfa.

Beet acreage in region 3 has declined in recent years, and the number of growers dropped by half between 1961-63 and 1971-73 (table 1). A 16-percent yield increase during the same period resulted in a net gain in beet production, and an increase in sucrose content increased sugar production even more.

The Great Western Sugar Company dominates beet processing in region 3. It operates all but 1 of the 14 factories operating in the region. That plant is operated by the Holly Sugar Company.

Region 4--Southern Plains

Region 4 consists of southwestern Kansas, southern Colorado, the Texas High Plains, and eastern New Mexico. Beets in region 4 are irrigated. Major competing crops are feed grains, wheat, alfalfa, and cotton in Texas.

The planted acreage figures in table 1 disguise some substantial changes in region 4 production during the last 10 years. Although acreage in Colorado and Kansas has been quite stable, Texas acreage jumped from practically none

in 1963 to a peak of 56,000 acres in 1969 before dropping to 24,000 acres in 1973. The acreage increase was prompted by establishment of a new factory in the State, and the decline resulted from consistently poor growing conditions and very low sugar yields.

Holly Sugar Company operates two plants in region 4 and American Crystal Sugar Company operates one. In addition, a substantial portion of production from the region is processed by factories in region 3.

Region 5--Montana-Wyoming

Sugarbeet production in region 5 is concentrated in southeastern Montana and north-central Wyoming. Scattered counties in western Montana, north-central Montana, and western and central North Dakota also report beet production. All acreage is irrigated. Major competing crops are feed grains and alfalfa, which reflect the importance of cattle feeding in most parts of the region.

Regions 3 and 5 were the only regions to exhibit a decline in sugarbeet acreage from 1961-63 to 1971-73. Because of a nearly 30-percent yield increase, beet production in region 5 increased by 20 percent during the same period. Farm numbers decreased by 40 percent, and average acreage per farm increased by 50 percent. Holly Sugar Company and Great Western Sugar Company share about equally in processing the region 5 crop.

Region 6--Intermountain

Sugarbeet production from Utah and eastern Idaho is classed in ASCS region 6. The region lies in the high elevation, low rainfall area between the Rocky Mountain and Cascade-Sierra ranges. All sugarbeet acreage in the region is irrigated. Hay, grain, and potatoes compete with sugarbeets for acreage and other resources.

Even though table 1 shows a 20-percent increase in region 6 acreage between 1961-63 and 1971-73, plantings have declined in recent years, especially in Utah. Utah acreage dropped steadily from about 35,000 acres in 1969 to less than 18,000 acres in 1974. Idaho acreage in region 6 dropped about 30 percent during the same period. Both States showed a sharp recovery in acreage in 1975.

Presently, four beet processing factories are located in region 6. The Utah-Idaho Sugar Company and the Almagamated Sugar Company each control two plants.

Region 7--Northwest

Region 7 consists of the western Idaho-eastern Oregon area and the Columbia Basin and Yakima Valley areas of Washington and Oregon. All beets are irrigated. Competing crops are diverse. Wheat, feed grains, and potatoes are the main crops in western Idaho-eastern Oregon. In Washington-northern Oregon, major competing crops are alfalfa, soybeans, potatoes, corn, wheat, and mint.

Acreage harvested increased 31 percent in region 7 between 1961-63 and 1971-73, the largest regional rate of gain in the United States (table 1). Most of this growth was in the Columbia Basin of Washington, where new irrigation projects substantially increased available land. Sugarbeet yields in the region are the highest in the Nation, although no yield change occurred from 1961-63 to 1971-73. Both the drop in farm numbers and the gain in average farm size in region 7 during that period were the largest changes for the eight regions.

Amalgamated Sugar Company operates two processing facotries in the western Idaho-eastern Oregon area of region 7, and Utah-Idaho Sugar Company operates two factories in Washington. The four factories are large; average daily slicing capacity is more than 7,500 tons. The Utah-Idaho factory at Moses Lake, Washington, is the largest U.S. beet processing plant, and it has a maximum daily slicing capacity of 10,500 tons.

Region 8--Far West

Region 8, the largest of the ASCS regions in terms of production, consists of California and Arizona. The region possesses several unique characteristics and actually includes six subregions which are more diverse than the other seven regions. Four subregions are in California: The Sacramento Valley (the interior valley north of the Sacramento River), the San Joaquin Valley (interior valley south of the Sacramento River), the Salinas Valley, and the Imperial Valley. Arizona production is split between the lowland area (Phoenix-Yuma) and the highland area (Willcox). In some of these subregions (Imperial Valley, lower San Joaquin Valley, and Arizona lowland), beets are planted in the fall and harvested in the spring, in contrast to all other regions. In other California subregions (Sacramento Valley, San Joaquin Valley, Salinas Valley), over-wintering of beets is common. That is, spring-planted beets are left in the ground after maturity to extent the processing season. In all subregions, sugarbeets are irrigated. More than 30 crops were grown on farms producing beets in a 1972 ASCS survey. The major competing crops are feed grains, wheat, cotton, and alfalfa.

Production trends vary among the subregions of region 8. Beet production in Arizona did not begin until 1966 with the construction of a factory by Speckels Sugar at Chandler. Planted acreage in Arizona reached a peak of about 30,000 acres in 1969 before dropping and stablizing at 10,000 to 15,000 acres. Within California, planted acreage has been generally declining in the Salinas Valley, stable in the San Joaquin Valley, and increasing in the Sacramento and Imperial Valleys.

Four firms presently operate 11 factories in region 8. Spreckels Sugar controls the sole Arizona factory and four plants in California. Holly Sugar Corporation operates four factories, and American Crystal Sugar Company and Union Sugar are single-plant firms.

Sugar Contracting and Pricing 6/

All U.S. sugarbeets are grown under contract. Contract terms are negotiated between growers and processors. Prior to the expiration of the U.S. Sugar Act, contracts were approved by the Secretary of Agriculture.

Sugarbeet contracts are unique in agricultural production in that they are participatory; rather than fixing a raw product price, contracts specify how the total finished production (refined sugar) returns are to be split between growers and processors. The key element in establishing grower-processor shares is the net selling price received by the processor for refined beet sugar sales.

Processor net selling prices are gross receipts for sugar sold during a specified time period (generally October 1-September 30, except for region 8) less specified marketing and transportation costs. Presently, costs to be deducted from gross prices are subject to negotiations. During the period of the U.S. Sugar Act, these costs were set through "fair price determinations," pricing formulas established by the Secretary of Agriculture through public hearings in various producing areas. Because of different levels of competition, freight rates, and other factors, processors in different regions and even within the same region would be unlikely to have the same net selling price.

Two types of contracts--the participating, or Western contract, and the 50-50, or Eastern contract--are used in the industry. These differ basically in the way in which beet prices per ton are computed from net selling prices. In the Western contract, used in all regions except in the East (region 1), a table of payments is shown which specifies beet price according to sucrose content and net selling price (3). A typical (abbreviated) price schedule for Western contracts is shown in table 4. Growers do not share in byproduct returns; receipts from molasses and beet pulp sales accrue solely to the processor.

Eastern contracts contain a price schedule that relates a base price per net ton of beets to processors' total returns for sugar, plus molasses and beet pulp sales, less associated marketing and transportation expenses. A typical Eastern contract price schedule is shown in table 5. To account for differences in sugar content of beets, the base price is adjusted according to the ratio of an individual grower's beet sugar content to the processor's average. For example, if a grower delivered beets testing 18-percent sugar and the company average sugar content for all beets sliced was 15 percent, the producer's payment per ton would be the base price times 1.2 (18 percent divided by 15 percent). A notable feature of the Eastern contract is that processor efficiency (extraction rate) has a direct bearing on grower returns. Returns for beets in the Western contract are based solely on net selling price and sugar content.

6/ See (1) for a more extensive discussion of beet pricing and interrelationships between beet and cane sugar prices.

Table 4--Typical Western sugarbeet contract price schedule

Net selling price	Average sugar content of beets delivered							
	25 percent	20 percent	19 percent	18 percent	17 percent	16 percent	15 percent	10 percent
Dollars per hundredweight	Dollars per ton of beets							
35	93.25	75.00	71.35	67.71	64.08	60.46	56.85	38.85
25	68.25	55.00	52.35	49.71	47.08	44.46	41.85	28.85
24	65.75	53.00	50.45	47.91	45.38	42.86	40.35	27.85
23	63.25	51.00	48.55	46.11	43.68	41.26	38.85	26.85
22	60.75	49.00	46.65	44.31	41.98	39.66	37.35	26.85
21	58.25	47.00	44.75	42.51	40.28	38.06	35.85	24.85
20	55.75	45.00	42.85	40.71	38.58	36.46	34.35	23.85
10	30.75	25.00	23.85	22.71	21.58	20.46	19.35	13.85

Table 5--Typical Eastern sugarbeet contract price schedule

Net value per ton of beets purchased 1/	Basic price per ton of beets purchased	Net value per ton of beets purchased 1/	Basic price per ton of beets purchased
Dollars		Dollars	
50	27.65	30	16.60
		29	16.04
40	22.12	28	15.48
39	21.57	27	14.93
38	21.01	26	14.38
37	20.46	25	13.82
36	19.91	24	13.27
35	19.36	23	12.72
34	18.80	22	11.90
33	18.25	21	10.92
32	17.70	20	10.00
31	17.14		
		10	5.00

1/ Gross value all sales of refined beet sugar, molasses, and beet pulp less applicable marketing expenses divided by total tonnage of beets purchased.

In addition to price schedules, other provisions typically contained in sugarbeet contracts include--

- Trimming specifications
- Tare definitions and quality standards
- Seed specifications
- Pesticide restrictions
- Timing of payments
- Hauling allowances
- Late or early delivery bonuses

Sugarbeet Production Costs

Estimated costs of producing sugarbeets for the 1975 crop year in the eight ASCS regions are summarized in table 6. Costs are based on Extension Service budgets prepared by specialists in the various States. Input prices and investment costs were updated to 1975 when necessary. The figures reflect average management practices on typical farms; actual costs incurred on individual farms would be expected to vary substantially both above and below those shown. 7/

Costs per acre vary from about $260 in region 2 to nearly $500 in regions 7 and 8. This difference reflects significantly higher land charges in the West and labor and water costs associated with irrigation.

Much more similarity is observed when costs are expressed on a per ton basis. In that case, the range in cost is from $17.27 (Red River Valley) to $23.02 (Intermountain region).

STATISTICAL ANALYSIS OF BEET SUGAR SUPPLY

General Nature of the Decisionmaking Process for Growers

Figure 2 schematically summarizes the items that affect a grower's planting decision, and it indicates major factors influencing the supply and price of sugarbeets. Arrows denote the directions of influence in the diagram. Broken lines reflect the causal relationships which applied only during the period of the U.S. Sugar Act, and solid lines represent relationships developed both during and after the act.

Beginning at the block "planted acreage," the planting decision is shown to be influenced by several factors. Institutional factors include land and climatalogical characteristics, form of contracts, type and location of processors (that is, "cooperative loyalty"), individual farm histories of sugarbeet production, and degree of asset fixidity. Technological factors relate to differences in cultural practices (that is, improvements in herbicides, pesticides, and chemicals), crop rotation constraints, and complementary cropping as well as cost factors. Competing crop prices and grower returns for beets are shown to affect plantings in a lagged fashion Lagged returns are viewed as proxies for current beet production profits.

7/ See (4) for an expanded discussion of sugarbeet production costs.

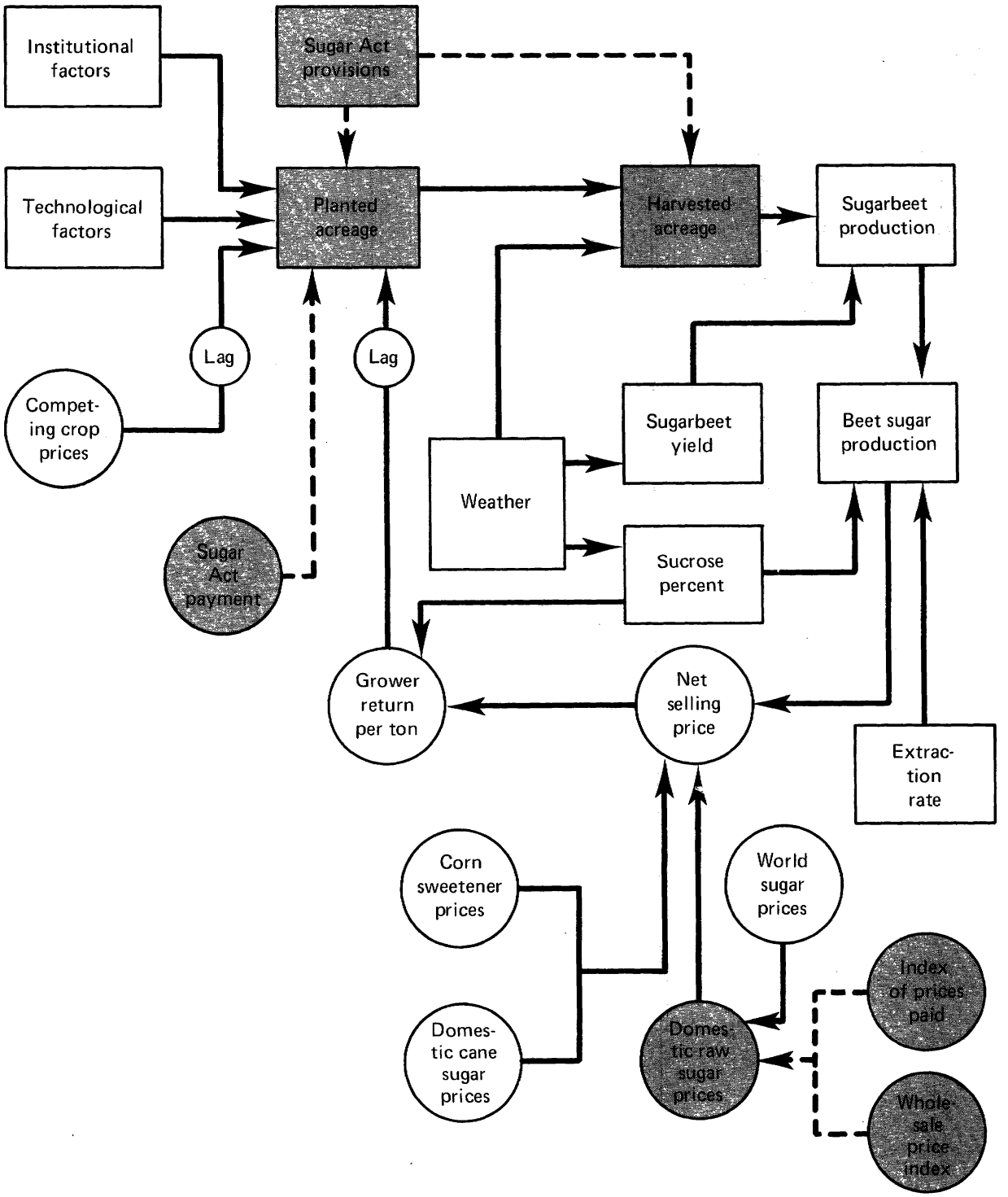
Table 6--Regional costs of producing sugarbeets in the United States, 1974/75 1/

ASCS region and budget subregion 2/	Subregion cost per acre	Weight region cost per acre	1971-73 yield	Weight region cost per ton
		Dollars	Tons	Dollars
1--East		321.79	17.9	17.98
Northwestern Ohio (3)	388.46			
East-Central Michigan (7)	293.22			
2--Red River Valley		264.28	15.3	17.27
Red River Valley (9)	265.28			
Southern Minnesota (1)	255.26			
3--Northern Plains		395.41	18.5	21.37
Nebraska Panhandle (4)	396.43			
Western Kansas (1)	355.61			
Eastern Colorado (5)	402.55			
4--Southern Plains		367.18	20.0	18.36
Eastern Colorado (3)	402.55			
Texas High Plains (4)	349.33			
Western Kansas (3)	355.61			
5--Montana-Wyoming		427.50	19.3	22.15
Montana Yellowstone Valley(5)	417.75			
Wyoming Big Horn Basin (5)	437.26			
6--Intermountain		414.43	18.0	23.02
South-Central Idaho (8)	436.71			
Utah	325.30			
7--Northwest		489.80	25.7	19.06
Western Idaho-Eastern Oregon (5)	520.01			
Washington Columbia Basin (5)	459.58			
8--Far West		494.44	25.4	19.47
Calif.-N. Central Valley(2.5)	524.71			
Calif.-S. Central Valley (4)	465.45			
Calif.-Coastal (1)	562.90			
Calif.-Desert (2)	496.11			
Arizona (.5)	431.36			

1/ Estimated costs based on input prices prevailing during Jan.-Apr., 1975. Includes land charge and imputed interest but no management charge.

2/ Budgets filed on ERS, USDA-Oklahoma State University Firm Enterprise Data System. Numbers in parentheses are weights (scale of 10) approximating proportion of total regional acreage represented by budget.

General Model of Sugarbeet Supply-Price Determination



**Dashes connect factors added during the U.S. Sugar Act.*

Figure 2

Sugar Act compliance payments and other provisions influenced beet plantings during the period the act was in effect. Government payments to beet producers were correlated with size of farm. Other provisions affecting plantings included individual farm acreage allotments and minimum wage rates.

Given the sugarbeet plantings, harvested acreage is related to abandonment, which is largely determined by weather conditions (drought, freezing, and flooding) during the growing season. When U.S. Sugar Act allotments were in effect, some abandonment was associated with overplanting of farm quotas. Abandoned acreage as a percentage of planted area, shown in table 7, averaged about 5 percent. It ranged from less than 3 percent in region 3 to more than 7 percent in region 4 during 1955-74. Substantial year-to-year variability is exhibited in all regions.

Beet production is the product of harvested acreage and yield. Beet yields are largely a function of weather conditions during growth (given climatological factors) and other random occurances, such as pest infestation. Given the beet tonnage, sugar production depends on the sucrose content of the beets and the extraction rate of the processing plant. Sucrose percentage is related to growing conditions, and in particular, the length of time beets are left in the ground or in storage after harvest. Extraction rates depend largely on factory efficiency and methods of processing.

Net selling price derivation was discussed in the preceding section. Basically, the net selling price for a particular firm depends on the geographic location (and resulting shipment costs), world sugar prices, and the total domestic supply of sweeteners--cane sugar and corn sweeteners in addition to beet sugar. Before the Sugar Act expired, a "price objective" for domestic raw sugar was administratively fixed, based on the index of prices paid by farmers and on the wholesale price index. U.S. raw prices closely followed this objective, and regional net selling prices for refined beet sugar were highly correlated with raw prices.

Return per ton of beets processed is specified from grower-processor contracts. Given the net selling price, an individual grower's return per ton would be based on trash deductions and on the sucrose content of beets delivered.

Sugarbeet Supply-Price Model

Figure 2 forms the basis of a set of statistical relationships simulating the planting decisions of growers, resulting beet sugar production, and sugarbeet price determination. A recursive model is defined which includes regional equations for planted acreage, harvested acreage, sugarbeet production, beet sugar production, and grower return per ton of beets. The nature of the model permits sequential projections of endogenous components under alternative assumptions concerning exogenous variables. The general form of the model equations is discussed in the following paragraphs.

Based on figure 2, an estimable regional sugarbeet planting equation is specified:

Table 7--Abandoned sugarbeet acreage as a percentage of planted area, 1955-74 crop years

Crop year beginning in	ASCS region							
	1	2	3	4	5	6	7	8
	Percent							
1955	5.9	2.2	18.6	7.6	1.3	3.8	6.7	2.9
1956	9.8	3.0	7.1	5.5	1.9	8.5	2.4	4.8
1957	5.8	9.8	3.0	4.8	1.7	4.3	1.4	3.5
1958	6.8	1.2	3.4	5.5	2.4	5.6	1.6	9.3
1959	7.0	5.7	2.9	2.0	10.4	5.5	3.6	2.7
1960	2.7	.4	1.4	2.6	1.6	3.3	2.0	1.6
1961	8.4	1.4	5.3	3.8	8.2	7.9	2.1	3.2
1962	12.2	7.0	10.2	4.2	2.4	2.3	2.7	6.1
1963	5.5	2.0	5.4	7.0	1.1	3.1	1.9	4.6
1964	8.2	2.5	5.3	7.0	1.8	5.7	3.4	2.9
1965	12.9	1.8	10.0	7.9	2.0	2.3	1.5	3.8
1966	4.2	1.3	7.1	5.7	4.3	16.0	5.9	7.0
1967	10.2	1.9	5.8	9.4	4.0	7.6	3.4	8.2
1968	3.3	1.3	6.2	5.1	2.6	6.9	7.3	4.0
1969	2.6	.5	9.8	21.3	1.8	12.3	4.1	4.8
1970	3.8	2.8	8.1	5.6	1.4	4.5	6.8	2.5
1971	7.1	2.3	8.7	6.7	6.3	5.0	2.5	1.5
1972	13.8	2.3	9.9	17.2	1.0	5.9	3.7	3.5
1973	3.2	.9	6.5	8.0	1.8	7.9	4.5	6.5
1974	2.3	3.1	4.6	7.6	1.4	3.9	2.1	1.8
1955-74 average	6.8	2.7	7.0	7.2	3.0	6.1	3.5	4.3

Source: Calculated from information provided by the Sugar Division, ASCS.

EQUATION 1

$$PLACR_t = f(PLACR_{t-1}, PRATIO_{t-1}, PRATIO_{t-2}, PRATIO_{t-3}, SLCAP_t, ALLOC_t, t)$$

The variables are defined as:

PLACR = Planted acreage of sugarbeets, acres.

PRATIO = Ratio of gross price per ton of sugarbeets and unit price for most important competing crop.

SLCAP = Aggregate daily slicing capacity for all plants in region, tons.

ALLOC = Dummy variable for imposition of proportionate shares during the period of the U.S. Sugar Act; ALLOC = 1 for years during which a binding acreage allocation was imposed, 0 otherwise. A binding allocation is arbitrarily defined as planted acreage within 5 percent of the regional quota.

t = Crop year when used as a subscript or in parentheses; trend when used as a variable (1955=1,..., 1974=20).

Use of lagged acreage in the planted acreage equation reflects a postulated partial adjustment process on the part of growers because of the fixidity of assets used in sugarbeet production and processing capacity constraints. That is, actual decreases in plantings are hypothesized to be less than desired (given price expectations), because growers have a large investment in specialized production equipment which would be underused in the event of a large decrease in planted acreage. Similarly, planting increases are hypothesized to be less than desired, because processors cannot rapidly increase processing capacity.

Prices of sugarbeets and competing crops are expressed as a ratio to avoid explicit price deflation in subsequent projections. Applicable competing crops were determined by experimenting with major regional competitors. The most important competing crop was judged to be the one yielding the largest R^2 value in Ordinary Least Squares (OLS) estimates of regional variants of equation 1. This selection procedure was deemed superior to arbitrarily selecting crops with the largest acreage on typical regional farms (table 3), because farm resource allocation would likely be on a marginal basis.

Beet prices include processor payments plus U.S. Sugar Act compliance payments. Superficially, this might appear to cause problems of consistency in examining the impact of grower returns after the expiration of the U.S. Sugar Act. However, a processor assessment of 50 cents per 100 pounds of refined beet sugar was dropped at the same time as producer compliance payments. Since this assessment roughly equalled compliance payments in the aggregate during the U.S. Sugar Act, an assumption of complete offset seem reasonable for the period following the act.

Daily slicing capacity reflects the maximum size of regional beet markets. The variable is only a proxy for processing constraints, since interregional beet shipments are common, particularly in regions 3, 4, 5, 6, and 7. The proportionate share dummy captures the effect of quotas imposed under the U.S. Sugar Act. Trend is used as a proxy for technological change and longrun changes in relative price relationships and biological and physical conditions.

Equations 2, 3, and 4 are simple relationships for harvested acreage, beet production, and refined beet sugar production.

EQUATION 2

$$HVACR_t = f(PLACR_t)$$

EQUATION 3

$$BPROD_t = f(HVACR_t, t)$$

EQUATION 4

$$SGPROD_t = f(BPROD_t, SGPCT_t, t)$$

The new variables introduced are:

HVACR = Harvested sugarbeet acreage, acres.

BPROD = Sugarbeet production, tons of beets.

SGPROD = Refined beet sugar production, tons.

SGPCT = Sucrose content of beets processed, percent.

The trend variable in equation 3 captures systematic changes in yields over time. In equation 4, trend reflects changes in sucrose content and processor extraction rates. In equation 2, unsuccessful attempts were made to relate abandoned acreage to beet yields, sucrose content, and prices. It was concluded that acreage abandonment is purely weather-related and, hence, a random process.

The final equation in the model relates grower returns to raw sugar prices and sucrose content.

EQUATION 5

$$GRRET_t = f(SGPRICE_t, SGPCT_t)$$

The new variables are:

GRRET = Grower returns per ton of beets, dollars. This includes processor payment plus U.S. Sugar Act payment.

SGPRICE = U.S. raw sugar price, duty paid, cents per pound (New York monthly raw spot price averaged during a September to August crop year).

Results of Estimation

The model represented by the five equations were estimated by Ordinary Least Squares (OLS) using actual values for all variables for the crop years 1955-74. Estimates for each of the eight regions were made by using separate equations.

For the planted acreage relation (equation 1), modifications of the basic equation were made based on individual regional characteristics. The specific results are shown in table 8. The hypothesized partial adjustment process was rejected for region 2 (Red River Valley), and lagged planted acreage was ommitted from the explanatory variable list. This variable was retained for regions 1 (East) and 7 (Northwest), but it is not significantly different from zero at the 90-percent confidence level.

Except for region 1 (East), 2- and 3-year lagged values of the beet-to-competing crop price ratio were not significant in explaining current-year sugarbeet plantings. This suggests that (adjusted for the lagged acreage variable) growers adjust plantings quite rapidly in response to relative price changes.

The slicing capacity variable was excluded from the planted acreage equations for regions 3, 4, 5, 6, and 7. The estimated coefficients for SLCAP were not significantly different from zero in these regions. This is consistent with expectations, since substantial interregional transfers of beets for processing occur in these contiguous regions.

The proportionate share dummy variable was judged insignificant in regions 1 (East), 2 (Red River Valley), 4 (Southern Plains), and 6 (Intermountain). Inspection of plantings relative to quotas in regions 1, 4, and 6 shows that growers did not appear to be constrained by quotas, particularly since 1960. The insignificant result in region 2 is not consistent with expectations, since planted acreage in this region equalled the allotment in most years when quotas were effective.

Regions 1 (East), 5 (Montana-Wyoming), 6 (Intermountain), and 8 (Far West) showed a negative trend in planted acreage net of the effect of other explanatory variables. However, all of these regions exhibit an increasing trend in yields (table 10). So, it is not necessarily appropriate to assume declining production in the absence of other factors.

Estimated coefficients and related statistics for equations 2 to 5 are shown in table 9 to 12. As indicated by the high R^2 values, the statistical "fit" of these equations is quite good. Estimated coefficients are significantly different from zero at the 99-percent level of confidence or

better except for the trend term for some regions in the beet production and sugar production equations. In these cases, yields and extraction rates or sugar percentages have exhibited no discernible changes over time.

BEET SUGAR SUPPLY PROJECTIONS

The model developed and estimated in the preceding section can be used to provide insights into several important questions related to the potential location and magnitude of sugarbeet production in the United States. Questions of particular interest in light of the demise of the U.S. Sugar Act include these:

- What will be the likely drop in U.S. beet sugar production if world raw sugar prices drop to pre-1973 levels?
- Which areas will exhibit the largest reductions in acreage?
- What raw sugar price levels would be necessary to retain a "viable" domestic beet sugar industry?

These questions are addressed by projecting regional beet sugar production under alternative assumptions with respect to raw sugar prices and returns for competing crops. A critical assumption in making these projections is that the basic decisionmaking structure of the U.S. beet sugar production-marketing system does not change markedly from the structure estimated in the preceding section. This assumption may be considered suspect in light of increased price uncertainty relative to the period when the U.S. Sugar Act was in effect. But insufficient time has passed to assess how this increased uncertainty has or will affect producer and processor decisions.

Regional Supply Schedules

Projection of regional supply functions for sugarbeet acreage requires some assumptions regarding those variables other than sugar prices which affect producer decisions. The following assumptions apply:

- Daily slicing capacity (SLCAP) is assumed to remain at estimated 1975 levels. This implies that no new beet processing facilities are constructed and that all existing plants remain in operation. So, excess slicing capacity is assumed to decline and increase, respectively, with increases and decreases in sugarbeet production.

- Acreage allotments are not applicable in the absence of a U.S. Sugar Act. So, the allotment dummy variable (ALLOC) in equation 1 is zero for the projection period.

- Three sets of competing crop prices are used, reflecting different assumptions concerning future general price levels relative to past trends. U.S. average grower returns for those crops judged to be the most important competitors with sugarbeets were regressed against time and a binary dummy variable to capture the influence of abnormally high crop prices during 1973-75. The resulting intercept shift variable is multiplied by 0, 0.5, and 1.0 and added to the estimated intercept to define three trend equations for projecting competing crop prices. Applicable equations and projected 1976 prices for the three cases (low, medium, and high levels) are shown in table 13.

- Time series analysis of regional sugar percentages showed no consistent trends. Hence, projected sugar percentages are set at 1971-73 averages (see table 1).

Given these assumptions along with the regional variants of equations 1 to 5 (see tables 8 to 12), supply functions relating planted sugarbeet acreage to lagged raw sugar prices can be defined for a specific year. 8/ Basically, this involves projecting regional acreage for the relevant year for two lagged New York spot raw price values and resolving the intercept and slope values. Regional supply functions for 1977 are shown in table 14. These are based on June 30, 1976, planted acreage estimates. Three linear relationships for each region and the United States are shown corresponding to three price levels for competing crops.

The equation slopes, indicating the change in plantings associated with a 1-cent change in the lagged New York spot price exhibit substantial variability by region. In the medium competing crop price case, for example, a 1-cent price change is shown to yield acreage changes in the same direction, ranging from less than 1,900 acres in the Intermountain region to more than 14,000 acres in the far West. A different picture emerges

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8/ A different equation from the one shown in table 8 was used for region 1 planted acreage to achieve consistency with the other regional equations (that is, the region 1 equation as shown has multiple lags in the price ratio variables). The region 1 equation used is:

$$PLACR_t = \underset{}{-16{,}216.24} + \underset{(2.58)}{0.6104}PLACR_{t-1} + \underset{(2.66)}{3924.96}PRATIO_{t-1} + \underset{(1.64)}{1.414}SLCAP_t \underset{(-1.04)}{-751.32}TIME$$

$$R^2 = .78$$

Table 8--Sugarbeet planted acreage equations

Region	Intercept	Explanatory variable 1/							R^2	Competing crop
		$PLACR_{t-1}$	$PRATIO_{t-1}$	$PRATIO_{t-2}$	$PRATIO_{t-3}$	$SLCAP_t$	$ALLOC_t$	TIME		
1--East	-99,573.06	0.2517 (1.42)	5,632.58 (5.34)	5,958.49 (5.65)	5,958.49 (2.22)	1.4032 (2.55)	--	-870.14 (2.01)	0.94	Corn
2--Red River Valley	-120,174.51	--	3,974.14 (1.30)	--	--	13.91 (10.38)	--	--	.88	Barley
3--Northern Plains	-94,593.41	.7596 (4.60)	25,904.92 (3.31)	--	--	--	-27,387.21 (-2.30)	--	.71	Soybeans
4--Southern Plains	-27,533.00	.8462 (7.30)	2,649.16 (1.88)	--	--	--	--	--	.77	Milo
5--Montana-Wyoming	841.32	.8164 (6.50)	2,503.64 (1.76)	--	--	--	-17,659.24 (-4.12)	-1,514.35 (-3.06)	.85	Barley
6--Intermountain	13,142.20	1.0416 (4.02)	38,206.94 (1.34)	--	--	--	-29,682.22 (-2.56)	-2,991.44 (1.57)	.78	Alfalfa
7--Northwest	58,589.34	.2383 (1.40)	4,129.64 (2.75)	--	--	--	-20,419.42 (-2.62)	--	.83	Wheat
8--Far West	-336,826.10	.4068 (1.77)	17,383.50 (2.81)	--	--	8.30 (2.17)	--	-7,572.52 (-1.74)	.75	Barley

1/ See text for definitions of variables. Figures in parentheses are t values. Dashes indicate that the variable was omitted in the specific regional equation.

Table 9--Harvested sugarbeet acreage equations

Region	Intercept	PLACR 1/	R^2	D.W.
1--East	-5,032.04	0.9720 (16.35)	0.94	2.25
2--Red River Valley	-4,512.28	1.0029 (66.62)	.99	2.65
3--Northern Plains	5,488.78	.9065 (18.76)	.95	1.19
4--Southern Plains	4,219.02	.8425 (21.51)	.96	2.66
5--Montana-Wyoming	-1,615.15	.9858 (29.15)	.98	2.41
6--Intermountain	3,390.13	.9080 (27.98)	.98	2.34
7--Northwest	2,583.68	.9417 (49.43)	.99	2.05
8--Far West	-5,060.40	.9752 (47.60)	.99	1.63

1/ Figures in parentheses are t values.

Table 10--Sugarbeet production equations

Region	Intercept	HVACR 1/	TIME 1/	R^2	D.W.
1--East	-202,319.79	15.0628 (4.46)	31,771.46 (2.92)	0.87	2.10
2--Red River Valley	166,157.44	7.9665 (3.20)	60,596.69 (2.78)	.90	2.42
3--Northern Plains	-477,379.31	17.5531 (6.77)	26,599.68 (1.54)	.84	2.25
4--Southern Plains	-156,526.23	19.0270 (14.56)	10,181.92 (2.72)	.97	2.19
5--Montana-Wyoming	230,318.12	10.4485 (3.64)	31,396.31 (3.57)	.82	2.25
6--Intermountain	419,661.97	10.7041 (5.64)	31,746.41 (3.00)	.92	2.44
7--Northwest	-826,900.00	34.8595 (6.26)	-37,587.42 (-1.49)	.94	2.09
8--Far West	-229,913.72	19.2329 (5.49)	94.728.90 (2.42)	.91	1.44

1/ Figures in parentheses are t values.

Table 11--Beet sugar production equations

Region	Intercept	BPROD 1/	SGRT 1/	TIME	R^2	D.W.
1--East	-197,138.99	0.0951 (8.88)	15,096.51 (5.82)	-227.24 (-.26)	0.96	1.84
2--Red River Valley	-260,354.29	.0887 (11.54)	19,123.67 (6.44)	1,693.80 (1.67)	.98	1.84
3--North Plains	-783,809.83	.1223 (9.20)	53,338.62 (5.52)	-918.75 (-.52)	.89	1.40
4--South Plains	-181,769.51	.1125 (19.87)	12,362.35 (8.96)	-222.88 (-.60)	.98	2.24
5--Montana-Wyoming	-134,801.82	.0876 (7.19)	12,176.67 (2.82)	141.78 (.18)	.91	1.38
6--Intermountain	-302.488.43	.1167 (9.27)	21.493.13 (3.04)	-1,097.56 (-.96)	.95	.80
7--Northwest	-417,563.79	.1034 (13.35)	30,385.22 (4.42)	2,848.82 (2.86)	.99	1.11
8--Far West	-520,757.61	.1260 (22.19)	36.504.58 (3.25)	-2,430.02 (-1.39)	.99	2.19

1/ Figures in parentheses are t values.

Table 12--Grower return per ton equations

Region	Intercept	New York spot price 1/	Sugar Percentage	R^2	D.W.
1--East	-11,572	1.4471 (17.56)	1.0012 (4.47)	0.96	1.41
2--Red River Valley	-7,186	1.2975 (24.18)	.8146 (4.51)	.97	.63
3--North Plains	-23.503	1.9550 (31.50)	1.5452 (8.31)	.98	2.22
4--South Plains	-15,192	1.6792 (30.91)	1.1556 (8.55)	.98	1.27
5--Montana-Wyoming	-11,906	1.8548 (35.84)	.8809 (3.69)	.99	1.74
6--Intermountain	-13,526	1.9102 (37.69)	.9684 (13.15)	.99	1.99
7--Northwest	-20,228	1.7774 (43.72)	1.4705 (5.05)	.99	1.37
8--Far West	-13,019	1.4370 (40.50)	1.1690 (5.24)	.99	2.48

1/ Figures in parentheses are t values.

Table 13--Competing crop price equations and projected 1976 crop prices 1/

Item	Corn	Wheat	Soybeans	Milo	Barley	Alfalfa
			Dollars per bushel			Dollars per ton
Trend equations:						
Slope	0.0036	-0.0393	0.0730	0.0110	0.0090	0.4789
Intercept--Low	1.1334	2.0119	1.8134	.9219	.8687	18.6168
Intercept--Medium	1.8738	3.3202	3.0020	1.5663	1.5846	28.3562
Intercept--High	2.6143	4.6285	4.1905	2.2106	2.3005	38.5124
Projected 1976 prices:						
Low	1.21	1.15	3.42	1.16	1.07	29.15
Medium	1.95	2.46	4.61	1.81	1.78	38.89
High	2.69	3.76	5.80	2.45	2.50	49.05
Actual prices:						
1955-72 average	1.17	1.64	2.51	1.03	.95	23.17
1973-75 average	2.69	3.84	5.65	2.43	2.48	48.10

1/ U.S. average farm prices.

Table 14--Regional sugarbeet supply relationships for 1977 crop year with low, medium, and high prices for competing crops

Region	Alternative crop price levels					
	Low		Medium		High	
	Intercept	Slope	Intercept	Slope	Intercept	Slope
1	91,748	4,781.1	87,150	2,968.6	85,080	2,152.2
2	353,695	4,834.0	346,165	2,892.6	342,948	2,063.9
3	102,942	14,810.8	99,953	10,990.5	98,191	8,737.0
4	20,178	3,822.1	18,909	2,460.1	18,308	1,813.8
5	49,527	4,353.4	47,299	2,605.0	46,347	1,858.6
6	56,286	2,503.5	55,640	1,876.6	55,240	1,488.0
7	104,304	6,397.7	99,500	2,989.1	98,036	1,950.1
8	83,683	23,418.1	54,128	14,013.2	41,509	9,998.0
United States 1/	862,363	64,920.5	808,747	40,795.5	785,660	30,061.8

1/ U.S. totals do not equal sum of regional intercepts and slopes because of rounding.

when acreage response is expressed in a relative sense. Point supply elasticities calculated at a 15-cent N.Y. spot price and 1976 estimated regional planted acreages are shown in table 15. The range in supply elasticities for the medium competing crop price case is from 0.11 in the Red River Valley to 0.67 in the Northern Plains. The Red River Valley, characterized by heavy incidence of grower cooperatives, is very insensitive to raw sugar price changes regardless of competing crop price levels.

Table 15--Point supply elasticities using 1976 regional acreage and a 15-cent N.Y. spot raw price

Region	Alternative crop price levels		
	Low	Medium	High
1	0.51	0.31	0.23
2	.18	.11	.08
3	.91	.67	.54
4	1.10	.71	.52
5	.68	.41	.29
6	.36	.27	.21
7	.62	.29	.19
8	1.03	.62	.44
United States	.64	.40	.29

In moving from low to high competing crop prices, sugarbeet growers' response to sugar prices drops dramatically. The regional slopes and elasticities for the high price case are one-half to one-third the levels for the low price case. This highlights the importance of competing crops in determining beet plantings. It is apparent that without the relatively high sugar prices of 1973-75, the generally high level of prices received by farmers for other crops would have resulted in substantially reduced sugarbeet acreage.

Projected supply functions for the United States (sum of regional functions) is shown graphically in figure 3. Again, the importance of competing crop prices is empahsized. For example, at a lagged N.Y. spot raw price of 15 cents per pound, U.S. sugarbeet acreage is shown to be 1,840,000, 1,420,000, and 1,235,000 acres, respectively, for the low, medium, and high competing crop price cases.

The projected 1977 supply functions can be used to determine what sugar prices would be needed to maintain regional sugarbeet acreages at recent historical levels. Table 16 shows June 30, 1976, Statistical Reporting Service, estimates of 1976 regional plantings and the 1976 crop year average New York spot raw sugar price which, based on the solution of equations in table 14, would yield the same regional acreage in 1977 with medium price levels for competing crops. These "stability" prices range from 13.2 cents per pound in the Northern Plains to 26.3 cents in the Intermountain region. A N.Y. spot raw sugar price of 17.7 cents is shown to achieve stability in the

Projected 1977 U.S. Sugarbeet Supply Functions

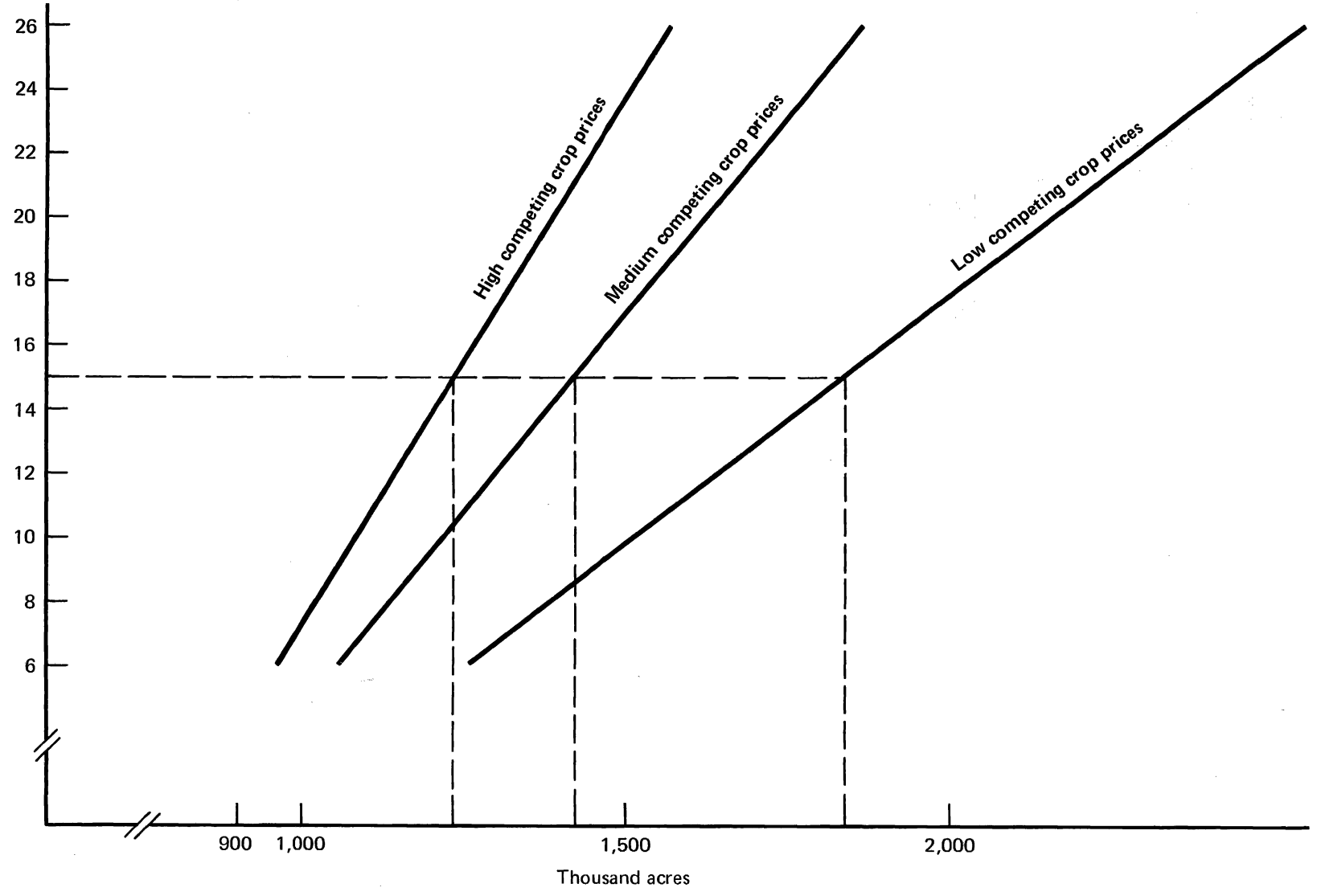


Figure 3

aggregate. This price would result in some locational shifts--acreage increases in the Northern and Southern Plains; slight declines in the East, Red River Valley, Montana-Wyoming, and Northwest; and more substantial drops in the Intermountain and Far West Regions.

Table 16--Projected 1976 prices consistent with regional stability in sugarbeet acreage and sugarbeet medium price levels for competing crops 1/

Region	Estimated 1976 planted acreage	Average 1976 N.Y. spot to maintain 1976 planted acreage in 1977	Resulting U.S. planted acreage
	1,000 acres	Cents per pound	1,000 acres
1	142.0	18.50	1,563.5
2	399.2	18.35	1,557.3
3	244.8	13.20	1,347.2
4	52.2	13.55	1,361.5
5	95.5	18.50	1,563.5
6	105.0	26.30	1,881.7
7	154.0	18.20	1,551.2
8	339.8	20.40	1,641.0
United States	1,532.5	17.73	1,532.5

1/ Average 1976 crop year prices which would yield no change in regional sugarbeet plantings from 1976 to 1977.

Longer Range Acreage Projections

The sugarbeet supply model can be used in a recursive fashion to trace the impact of sugar prices on regional and aggregate sugarbeet acreage over an extended period of time. This permits appraisal of how selected price levels would differentially affect regional beet production, or alternatively, what price levels would be needed to maintain selected levels of regional and aggregate production in the longer run, given existing processing capacity. 9/

A computer program was designed to facilitate intermediate and longrun acreage projections for sugarbeets. Basically, the program uses the equations estimated in the preceding section and the assumptions previously outlined. It operates recursively by using generated lagged values of regional planted acreage as input for current supply iterations. A general description of the program, control car formats, program statements, and exemplary output are provided in the appendix.

9/ The effect of changes in processing capacity can be assessed only for the East, Red River Valley, and far West regions (see table 8).

The question of requisite sugar price levels to maintain the longrun viability of the domestic sugarbeet industry is addressed by projecting sugarbeet acreage to 1980 under alternative N.Y. spot raw sugar prices assumed to be constant during 1976-79. Table 17 shows 1980 U.S. acreage ranging from 50 to 120 percent of 1976 and 1976-69 sugar prices, consistent with these projected acreage values. Locational shifts projected to occur with the assumed prices are shown in the table. Medium price levels for competing crops are used.

Several conclusions are suggested by table 17. It is apparent that raw sugar prices at or near those experienced before 1973 (less than 12 cents per pound) would result in substantial industry contraction. A 1976-79 N.Y. spot raw sugar price of 18.40 cents per pound is shown as needed to maintain 1980 U.S. beet acreage at 1976 levels. With prices of less than 12 cents, acreage drops to less than 1 million. These acreage projections are based on competing crop price trends which yield 1976-79 unit crop values less than those experienced in 1973-75. So, if the index of prices received for crops remains at recent levels, even higher sugar prices would be needed to maintain stable sugarbeet acreage.

Significant regional shifts in the location of sugarbeet production are shown to occur in table 17, even with raw sugar prices which maintain aggregate production close to recent levels. With stable U.S. acreage (N.Y. spot raw price equalling 18.4 cents per pound), planted acreage in regions 1, 2, and 7 is nearly the same as in 1976. Regions 3 and 4 exhibit large increases of 50 and 71 percent, respectively. Region 5 drops 10 percent, and region 8 drops 23 percent. Region 6 planted acreage is only 20 percent of its 1976 level.

With lower prices, the interregional shifts are even more pronounced. Planted sugarbeet acreage in regions 2 and 7 is quite stable. Red River Valley acreage in 1980 declines only 7 percent from 1976 with average 1967-79 raw sugar prices of 9.2 cents per pound. In the Northwest, the comparable decline is 22 percent. The East, Northern Plains, and Southern Plains drop by about 50 percent, and Montana-Wyoming and the West drop nearly 90 percent. In the Intermountain region, nearly no sugarbeet acreage is shown in 1980 with raw sugar prices of less than 15 cents per pound.

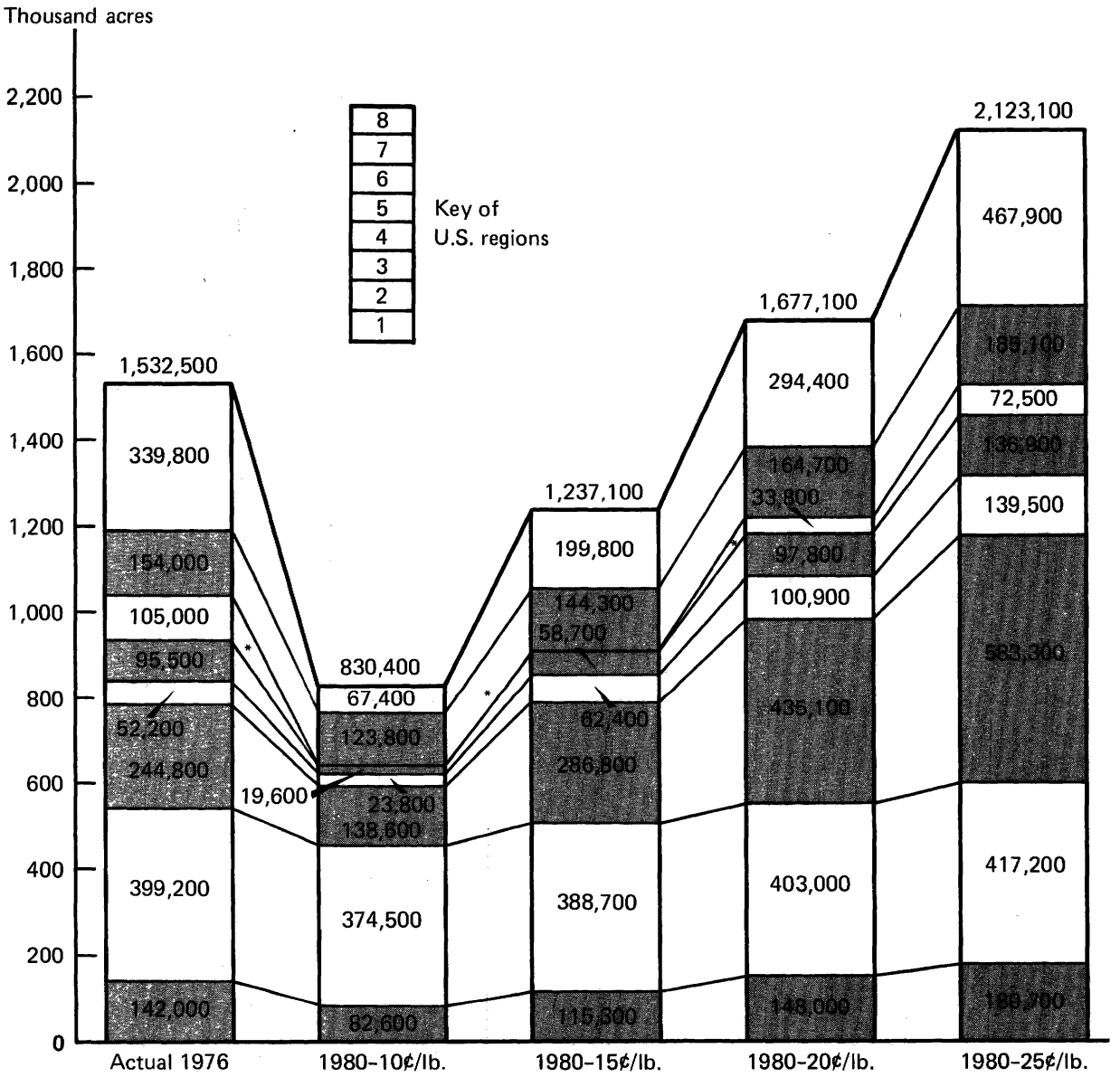
Figure 4 graphically illustrates regional production shifts and changes in aggregate U.S. acreage to 1980 under selected 1967-79 raw sugar price levels (medium price levels for competing crops). In general, regions 1, 2, and 3 show the smallest acreage changes with low sugar prices. Regions 3 and 4 show the largest gains with higher prices.

Table 17--Projected 1976-79 N.Y. spot raw sugar prices consistent with selected levels of U.S. sugarbeet acreage in 1980 and medium price levels for competing crops

N.Y. spot raw sugar price, 1976-79	1980 U.S. sugarbeet acreage		1980 regional beet acreage as a percentage of 1976 1/							
	Actual	Percentage of 1976 2/	1	2	3	4	5	6	7	8
Cents per pound	1,000 acres		Percent							
9.2	766.2	50	54	93	45	31	12	0	78	13
11.1	919.5	60	63	95	69	60	29	0	83	27
13.0	1,072.8	70	72	96	93	90	45	0	88	40
14.9	1.226.0	80	81	97	117	119	61	0	93	53
16.7	1,379.3	90	88	99	130	142	74	6	98	64
18.4	1,532.5	100	97	100	159	171	90	20	103	77
20.1	1,685.8	110	104	101	177	193	102	31	107	87
21.8	1,839.0	120	113	102	201	222	118	46	112	100

1/ June 30, 1976, SRS estimate.
2/ Regional 1976 acreages are as follows: 1--142,000, 2--399,200, 3--244,800, 4--52,200, 5--95,500, 6--105,000, 7--154,000, 8--339,800.

Actual 1976 and Projected 1980 Sugarbeet Acreage with Alternative Raw Sugar Prices



**Region 6 (Intermountain) acreage to zero for 10 and 15 cent prices.*

Figure 4

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APPENDIX--U.S. SUGARBEET PROJECTION PROGRAM

The program outlined here projects regional and U. S. sugarbeet acreage and production to any year, given the user-specified New York spot raw sugar prices during the projection period. Prices for crops competing with beets are internally generated as trend values based on the period 1955-75. The user may specify an intercept shift for alternative crop prices of full, half, or zero levels to reflect different assumptions cncerning future crop prices. Regional sugar percentages are set at 1971-73 average values. Total regional beet slicing capacities are assumed to remain at observed 1976 levels. The program is based on the econometric model discussed in the text.

The program uses two or three control cards per run for user-specified input. Control card formats are outined in appendix table 1. Program output includes regional (eight ASCS regions) and U. S. planted acreage, harvested acreage, beet and beet sugar production, grower prices (lagged 1 year) and planted acreage as a percentage of base year and U. S. total. The program is written in FORTRAN IV. Program statements are shown in appendix table 2. Some examples of program use follow.

Single-year supply functions.--To specify regional linear supply functions, only 2 price-quantity points are required. So, set A1 and A2 at relevant price bounds and set A3 at A2-A1. Example output for 1977 with New York raw prices at 10 and 20 cents is shown in appendix table 3 (medium crop prices).

Trace impact of single price.--To determine the temporal change in regional and total beet production for a constant price during the projection period, set A2 equal to A1 and set N3 equal to 2. A3 can be any value, since price will not be incremented. If more than one price is of interest, use appropriate values for the price bounds and price increment, or set the multiple-run code (N5) equal to the number of single prices under consideration. Example output for a 15-cent New York price from 1977 to 1980 is shown in appendix table 4 (medium crop prices).

Trace impact of price series.--A possible use of the projection program is to examine beet production changes resulting from an exogenously derived time series of projected raw sugar prices (for example, generated from a model of international free trade in sugar) in which successive prices are not equally incremented. In this case, the multiple-run code (N5) is set at zero, and a third control card is read containing the appropriate price series. (Note that this option does not permit more than a single run). An example of this case is shown in appendix table 5. New York spot prices are 1976-79 values generated by a sugar free trade model assuming normal weather (4). Alternative crop prices are at medium levels.

Appendix table 1--Control card formats

Card and Parameter	Column	Description
Card 1:		
N1	2-5	Base year for projections; generally last year for which planted acreage or price data or both are available.
N2	7-10	End year for projections. Projections beyond 1980 are increasingly tenuous because of the assumption of fixed processing capacity.
A1	11-15	Lower bound for N.Y. spot raw sugar price in cents per pound. Punch decimal point.
A2	16-20	Upper bound for N.Y. spot raw sugar price in cents per pound. Punch decimal point.
A3	21-25	Price increment for equal price changes. If this option is used, A2-A1 must be evenly divisible by A3. Punch decimal point.
N3	30	Suppress code for output other than end year for projections. Use 1 for suppression; 2 for full printout.
N4	35	Code for selection of alternative crop prices. Use 1 for low prices, 2 for medium, 3 for high (1973-78 intercept shift times 0, 0.5, and 1.0, respectively).

Continued

Appendix table 1--Control card formats--Continued

Card and parameter	Column	Description
Card 1:		
N5	36-40	Multiple-run code. Use nonzero integers for number of conventional runs (2-card control card sets). Use zero for unequal price change runs, and include third control card.
Card 2:		
PAB (1)	1-10	Base year planted acreage by ASCS region.
PAB (2)	11-20	
PAB (8)	71-80	
Card 3 (for runs with N5=0):		
PRICE (1)	1-5	Prices for unequal price change runs (N.Y. spot raw). Number of prices must equal N2-N1. Prices will be lagged values resulting in year t acreages.
PRICE (2)	6-10	
PRICE (n)	76-80	

Appendix table 2--Program statements

```
      DIMENSION RGR(8),RPA(8),RHA(8),RBP(8),RSP(8),PAB(8),LPA(8),RPB(8),
     1RPU(8),PRICE(8)
  500 FORMAT(2I5,3F5.0,3I5,/8F10.0)
  510 FORMAT(16F5.0)
  600 FORMAT(///10X,'PROJECTED REGIONAL SUGARBEET STATISTICS',/
     110X,'YEAR--',I5,/10X,'NY SPOT RAW (CENTS/LB.)--',F6.2,//
     212X,'PLANTED    HARV.     BEET      SUGAR  GROWER PR. PL. A',     '
     3CR. AS PCT. OF',/1X,'REGION',6X,'ACRES     ACRES     PROD.     PRO
     4D   FOR BEETS',3X,I6,6X,'U.S.',/32X,'(TONS)    (TONS)   ($/TON)'/)
  610 FORMAT(3X,I2,5X,4F10.0,3F10.2)
  620 FORMAT(2X,'U.S.',4X,4F10.0,3F10.2)
  630 FORMAT(1H1,'*********      E N D  O F  J O B          (6/12/76   EVJ')
  640 FORMAT(1H1,///10X,'CONTROL CARDS',/10X,2I5,3F5.2,3I5,/10X,8F10.0)
      MCODE=0
C     INITIALIZE VARIABLES
    1 MCODE=MCODE+1
      READ(5,500)N1,N2,A1,A2,A3,N3,N4,N5,(PAB(I),I=1,8)
C     N1=BASE YEAR (I.E., 1975)
C     N2=FINAL PROJECTION YEAR (I.E., 1980)
C     A1=NY SPOT PRICE LOWER BOUND IN CENTS PER LB.
C     A2=NY SPOT PRICE UPPER BOUND IN CENTS PER LB.
C     A3=PRICE CHANGE INCREMENT IN CENTS
C     N3=CODE FOR SUPPRESSION OF INTERMEDIATE OUTPUT
C        1--PRINTS ONLY FINAL YEAR
C        2--PRINTS ALL YEARS
C     N4=CODE FOR ALTERNATIVE CROP PRICES
C        1--1973-75 INTERCEPT SHIFTER * 0.0
C        2--1973-75 INTERCEPT SHIFTER * 0.5
C        3--1973-75 INTERCEPT SHIFTER * 1.0
C     N5=MULTIPLE-RUN CODE.
C        0--UNEQUAL PRICE SERIES.  FOLLOW SECOND CONTROL CARD WITH CARD
C           CONTAINING N2-N1 PRICES.
C        1-9--NUMBER OF CONVENTIONAL MULTIPLE RUNS.  FOLLOW PROGRAM WITH
C           SAME NUMBER OF CONTROL CARD SETS.
      WRITE(6,640)N1,N2,A1,A2,A3,N3,N4,N5,(PAB(I),I=1,8)
      N=N2-N1
      IF(N5.NE.0)GO TO 2
      READ(5,510)(PRICE(I),I=1,N)
    2 SPOT=A1
    3 DO100I=1,N
      IF(N5.EQ.0)SPOT=PRICE(I)
      RGR(1)=3.7464+1.4771*SPOT
      RGR(2)=5.0330+1.2975*SPOT
      RGR(3)=1.5292+1.9550*SPOT
      RGR(4)=1.5642+1.6792*SPOT
      RGR(5)=2.3646+1.8548*SPOT
      RGR(6)=1.9684+1.9102*SPOT
      RGR(7)=2.5048+1.7774*SPOT
      RGR(8)=4.5160+1.4370*SPOT
      TIML=N1-1955+I
      TIME=TIML+1.0
      DO4J=1,8
      LPA(J)=PAB(J)
    4 IF(I.GT.1)LPA(J)=RPA(J)
      GOTO(5,10,12),N4
    5 RPA(1)= 3924.96*(RGR(1)/(1.1334+0.0036*TIML))-751.32*TIME+0.6104*L
     1PA(1)+10225.56
      RPA(2)=3974.14*(RGR(2)/(0.8687+0.0090*TIML))+334943.76
      RPA(3)=25904.92*(RGR(3)/(1.8134+0.0730*TIML))+0.7596*LPA(3)
     1-94593.
      RPA(4)=2649.16*(RGR(4)/(0.9219+0.0110*TIML))+0.8462*LPA(4)-27553.
      RPA(5)=2503.64*(RGR(5)/(0.8687+0.0090*TIML))+0.8164*LPA(5)-1514.35
     1*TIME+841.32
      RPA(6)=38206.94*(RGR(6)/(18.617+0.4789*TIML))+1.0416*LPA(6)-2991.4
```

Continued

```
  14*TIME+13142.20
   RPA(7)=4129.64*(RGR(7)/(2.0119-0.0393*TIML))+0.2383*LPA(7)+58589.3
   RPA(8)=17383.50*(RGR(8)/(0.8687+0.0090*TIML))+0.4068*LPA(8)-7572.5
  12*TIME+46025.28
   GO TO 15
10 RPA(1)= 3924.96*(RGR(1)/(1.8738+0.0036*TIML))-751.32*TIME+0.6104*L
  1PA(1)+10225.56
   RPA(2)=3974.14*(RGR(2)/(1.5846+0.0090*TIML))+334943.76
   RPA(3)=25904.92*(RGR(3)/(3.0020+0.0730*TIML))+0.7596*LPA(3)
  1-94593.
   RPA(4)=2649.16*(RGR(4)/(1.5663+0.0110*TIML))+0.8462*LPA(4)-27553.
   RPA(5)=2503.64*(RGR(5)/(1.5846+0.0090*TIML))+0.8164*LPA(5)-1514.35
  1*TIME+841.32
   RPA(6)=38206.94*(RGR(6)/(28.356+0.4789*TIML))+1.0416*LPA(6)-2991.4
  14*TIME+13142.20
   RPA(7)=4129.64*(RGR(7)/(3.3202-0.0393*TIML))+0.2383*LPA(7)+58589.3
   RPA(8)=17383.50*(RGR(8)/(1.5846+0.0090*TIML))+0.4068*LPA(8)-7572.5
  12*TIME+46025.28
   GO TO 15



12 RPA(1)= 3924.96*(RGR(1)/(2.6143+0.0036*TIML))-751.32*TIME+0.6104*L
  1PA(1)+10225.56
   RPA(2)=3974.14*(RGR(2)/(2.3005+0.0090*TIML))+334943.76
   RPA(3)=25904.92*(RGR(3)/(4.1905+0.0730*TIML))+0.7596*LPA(3)
  1-94593.
   RPA(4)=2649.16*(RGR(4)/(2.2106+0.0110*TIML))+0.8462*LPA(4)-27553.
   RPA(5)=2503.64*(RGR(5)/(2.3005+0.0090*TIML))+0.8164*LPA(5)-1514.35
  1*TIME+841.32
   RPA(6)=38206.94*(RGR(6)/(38.512+0.4789*TIML))+1.0416*LPA(6)-2991.4
  14*TIME+13142.20
   RPA(7)=4129.64*(RGR(7)/(4.6285-0.0393*TIML))+0.2383*LPA(7)+58589.3
   RPA(8)=17383.50*(RGR(8)/(2.3005+0.0090*TIML))+0.4068*LPA(8)-7572.5
  12*TIME+46025.28
15 UPA=0.0
   DO20J=1,8
   IF(RPA(J).LT.0.0)RPA(J)=0.0
20 UPA=UPA+RPA(J)
   RHA(1)=0.9720*RPA(1)-5032.04
   RHA(2)=1.0029*RPA(2)-4512.28
   RHA(3)=0.9065*RPA(3)+5488.78
   RHA(4)=0.8425*RPA(4)+4219.02
   RHA(5)=0.9858*RPA(5)-1615.15
   RHA(6)=0.9080*RPA(6)+3590.13
   RHA(7)=0.9417*RPA(7)+2593.68
   RHA(8)=0.9752*RPA(8)-5060.40
   UHA=0.0
   DO30J=1,8
   IF(RPA(J).LE.0.0)RHA(J)=0.0
30 UHA=UHA+RHA(J)
   RBP(1)=15.0628*RHA(1)+31771.46*TIME-202319.79
   RBP(2)= 7.9665*RHA(2)+60596.69*TIME+166157.44
   RBP(3)=17.5531*RHA(3)+26599.68*TIME-477379.31
   RBP(4)=19.0270*RHA(4)+10181.92*TIME-156526.23
   RBP(5)=10.4485*RHA(5)+31396.31*TIME+230318.12
   RBP(6)=10.7041*RHA(6)+31746.41*TIME+419661.97
   RBP(7)=34.8595*RHA(7)-37587.42*TIME-826900.00
   RBP(8)=19.2329*RHA(8)+94728.90*TIME-229913.72
   UBP=0.0
   DO40J=1,8
   IF(RHA(J).LE.0.0)RBP(J)=0.0
```

Continued

Appendix table 2--Program statements--Continued

```
 40 UBP=UBP+RBP(J)
    RSP(1)=0.0951*RBP(1)- 227.24*TIME+33837.6
    RSP(2)=0.0887*RBP(2)+1693.80*TIME+26500.8
    RSP(3)=0.1223*RBP(3)- 918.75*TIME+80275.8
    RSP(4)=0.1125*RBP(4)- 222.88*TIME- 2515.4
    RSP(5)=0.0876*RBP(5)+ 141.78*TIME+62460.2
    RSP(6)=0.1167*RBP(6)-1097.56*TIME+62460.2
    RSP(7)=0.1034*RBP(7)+2848.82*TIME+53407.1
    RSP(8)=0.1260*RBP(8)-2430.02*TIME+26811.1
    USP=0.0
    DO50J=1,8
    IF(RBP(J).LE.0.0)RSP(J)=0.0
 50 USP=USP+RSP(J)
    IF(N3.EQ.1.AND.I.LT.N)GOTO100
    IYEAR=N1+I
    WRITE(6,600)IYEAR,SPOT,N1
    UPB=0.0
    UGR=0.0
    DO60J=1,8
    UPB=UPB+PAB(J)
    UGR=UGR+(RBP(J)*RGR(J))/UBP
    RPU(J)=(RPA(J)/UPA)*100.0
    RPB(J)=(RPA(J)/PAB(J))*100.0
 60 WRITE(6,610)J,RPA(J),RHA(J),RBP(J),RSP(J),RGR(J),RPB(J),RPU(J)
    UPU=(UPA/UPA)*100.0
    UPB=(UPA/UPB)*100.0
    WRITE(6,620)UPA,UHA,UBP,USP,UGR,UPB,UPU
100 CONTINUE
    IF(SPOT.EQ.A2)GOTO999
    SPOT=SPOT+A3
    GOTO3
999 IF(N5.EQ.0)GO TO 9999
    IF(MCODE.EQ.N5)GOTO9999
    GOTO1
9999 WRITE(6,630)
    STOP
    END
```

Appendix table 3--Examples of program statements

```
CONTROL CARDS
 1976 197710.0020.0010.00    1    2    1
   133000.   404000.   255100.   61600.   93700.   113900.   147700.   332000.
```

PROJECTED REGIONAL SUGARBEET STATISTICS
YEAR-- 1977
NY SPOT RAW (CENTS/LB.)-- 10.00

REGION	PLANTED ACRES	HARV. ACRES	BEET PROD. (TONS)	SUGAR PROD (TONS)	GROWER PR. FOR BEETS ($/TON)	PL. ACR. AS PCT. OF 1976	U.S.
1	111343.	103193.	2082801.	226685.	18.52	83.72	9.05
2	375091.	371666.	4520759.	466449.	18.01	92.84	30.49
3	217682.	202818.	3694492.	510981.	21.08	85.33	17.70
4	51465.	47578.	982924.	102937.	18.36	83.55	4.18
5	71879.	69243.	1675923.	212532.	20.91	76.71	5.84
6	83677.	79569.	2001538.	270796.	21.07	73.47	6.80
7	127889.	123027.	2597250.	387486.	20.28	86.59	10.40
8	191087.	181287.	5435528.	655797.	18.89	57.56	15.53
U.S.	1230112.	1178381.	22991200.	2833660.	19.50	79.83	100.00

PROJECTED REGIONAL SUGARBEET STATISTICS
YEAR-- 1977
NY SPOT RAW (CENTS/LB.)-- 20.00

REGION	PLANTED ACRES	HARV. ACRES	BEET PROD. (TONS)	SUGAR PROD (TONS)	GROWER PR. FOR BEETS ($/TON)	PL. ACR. AS PCT. OF 1976	U.S.
1	141028.	132047.	2517426.	268018.	33.29	106.04	8.61
2	404017.	400677.	4751870.	486949.	30.98	100.00	24.66
3	327587.	302446.	5443284.	724858.	40.63	128.42	20.00
4	76065.	68304.	1377270.	147301.	35.15	123.48	4.64
5	97930.	94924.	1944245.	236037.	39.46	104.51	5.98
6	102442.	96608.	2183927.	292081.	40.17	89.94	6.25
7	157780.	151175.	3578486.	488945.	38.05	106.82	9.63
8	331219.	317945.	8063846.	986965.	33.26	99.76	20.22
U.S.	1638068.	1564124.	29860336.	3631152.	35.81	106.30	100.00

Continued

Appendix table 3--Examples of program statements--Continued

```
CONTROL CARDS
 1976 198015.0015.00 5.00    2     2     1
   133000.   404000.   255100.    61600.    93700.   113900.   147700.   332000.
```

PROJECTED REGIONAL SUGARBEET STATISTICS
YEAR-- 1977
NY SPOT RAW (CENTS/LB.)-- 15.00

REGION	PLANTED ACRES	HARV. ACRES	BEET PROD. (TONS)	SUGAR PROD (TONS)	GROWER PR. FOR BEETS ($/TON)	PL. ACR. AS PCT. OF 1976	U.S.
1	126186.	117620.	2300113.	247352.	25.90	94.88	8.80
2	389554.	386172.	4636315.	476699.	24.50	96.42	27.16
3	272635.	252632.	4568889.	617920.	30.85	106.87	19.01
4	63765.	57941.	1180097.	125119.	26.75	103.51	4.45
5	84905.	82084.	1810083.	224284.	30.19	90.61	5.92
6	93060.	88088.	2092733.	281438.	30.62	81.70	6.49
7	142835.	137101.	3087869.	438216.	29.17	96.71	9.96
8	261153.	249616.	6749685.	821381.	26.07	78.66	18.21
U.S.	1434090.	1371252.	26425776.	3232406.	27.64	93.06	100.00

PROJECTED REGIONAL SUGARBEET STATISTICS
YEAR-- 1978
NY SPOT RAW (CENTS/LB.)-- 15.00

REGION	PLANTED ACRES	HARV. ACRES	BEET PROD. (TONS)	SUGAR PROD (TONS)	GROWER PR. FOR BEETS ($/TON)	PL. ACR. AS PCT. OF 1976	U.S.
1	121179.	112754.	2258578.	243174.	25.90	91.11	8.85
2	389280.	385896.	4694720.	483574.	24.50	96.36	28.44
3	283249.	262254.	4764375.	640909.	30.85	111.03	20.69
4	65359.	59284.	1215835.	128917.	26.75	106.10	4.77
5	75996.	73302.	1749722.	219139.	30.19	81.11	5.55
6	67994.	65329.	1890862.	255615.	30.62	59.70	4.97
7	142473.	136761.	3038405.	435950.	29.17	96.46	10.41
8	223482.	212880.	6137869.	741862.	26.07	67.31	16.32
U.S.	1369011.	1308457.	25740352.	3149136.	27.66	88.84	100.00

PROJECTED REGIONAL SUGARBEET STATISTICS
YEAR-- 1979
NY SPOT RAW (CENTS/LB.)-- 15.00

REGION	PLANTED ACRES	HARV. ACRES	BEET PROD. (TONS)	SUGAR PROD (TONS)	GROWER PR. FOR BEETS ($/TON)	PL. ACR. AS PCT. OF 1976	U.S.
1	117276.	108960.	2233204.	240534.	25.90	88.18	8.96
2	389008.	385624.	4753147.	490450.	24.50	96.29	29.71
3	288689.	267185.	4877541.	653830.	30.85	113.17	22.05
4	66475.	60224.	1243900.	131851.	26.75	107.91	5.08
5	66999.	64432.	1688442.	213912.	30.19	71.50	5.12
6	38538.	38583.	1626314.	224812.	30.62	33.83	2.94
7	143211.	137456.	3025047.	437417.	29.17	96.96	10.94
8	199321.	189318.	5779434.	694269.	26.07	60.04	15.22
U.S.	1309516.	1251779.	25227008.	3087075.	27.66	84.98	100.00

Continued

Appendix table 3--Examples of program statements--Continued

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PROJECTED REGIONAL SUGARBEET STATISTICS
YEAR-- 1980
NY SPOT RAW (CENTS/LB.)-- 15.00

REGION   PLANTED ACRES   HARV. ACRES   BEET PROD. (TONS)   SUGAR PROD (TONS)   GROWER PR. FOR BEETS ($/TON)   PL. ACR. AS PCT. OF 1976   PCT. OF U.S.
   1        114047.       105821.      2217703.            238833.              25.90                        85.75                    9.14
   2        388739.       385354.      4811595.            497328.              24.50                        96.22                   31.16
   3        290279.       268627.      4929446.            659260.              30.85                       113.79                   23.27
   4         67187.        60824.      1265498.            134058.              26.75                       109.07                    5.39
   5         57929.        55492.      1626427.            208621.              30.19                        61.82                    4.64
   6          4515.         7690.      1327384.            188829.              30.62                         3.96                    0.36
   7        144239.       138423.      3021196.            439868.              29.17                        97.66                   11.56
   8        180668.       171127.      5524308.            659693.              26.07                        54.42                   14.48
U.S.       1247604.      1193358.     24723552.           3026489.              27.63                        80.96                  100.00

CONTROL CARDS
 1976 198017.9015.40 0.0     2     2     0
   133000.   404000.   255100.   61600.   93700.   113900.   147700.   332000.

PROJECTED REGIONAL SUGARBEET STATISTICS
YEAR-- 1977
NY SPOT RAW (CENTS/LB.)-- 17.90

REGION   PLANTED ACRES   HARV. ACRES   BEET PROD. (TONS)   SUGAR PROD (TONS)   GROWER PR. FOR BEETS ($/TON)   PL. ACR. AS PCT. OF 1976   PCT. OF U.S.
   1        134794.       125988.      2426155.            259338.              30.19                       101.35                    8.68
   2        397943.       394585.      4703337.            482644.              28.26                        98.50                   25.63
   3        304507.       281524.      5076036.            679944.              36.52                       119.37                   19.62
   4         70899.        63951.      1294459.            137985.              31.62                       115.10                    4.57
   5         92459.        89531.      1887897.            231101.              35.57                        98.68                    5.96
   6         98502.        93030.      2145626.            287611.              36.16                        86.48                    6.35
   7        151503.       145264.      3372427.            467639.              34.32                       102.58                    9.76
   8        301791.       289247.      7511897.            917419.              30.24                        90.90                   19.44
U.S.       1552397.      1483118.     28417808.           3463677.              32.38                       100.74                  100.00

PROJECTED REGIONAL SUGARBEET STATISTICS
YEAR-- 1978
NY SPOT RAW (CENTS/LB.)-- 13.80

REGION   PLANTED ACRES   HARV. ACRES   BEET PROD. (TONS)   SUGAR PROD (TONS)   GROWER PR. FOR BEETS ($/TON)   PL. ACR. AS PCT. OF 1976   PCT. OF U.S.
   1        122878.       114405.      2283456.            245540.              24.13                        92.39                    8.86
   2        385826.       382433.      4667126.            481126.              22.94                        95.50                   27.83
   3        294476.       272432.      4943030.            662759.              28.51                       115.44                   21.24
   4         68462.        61898.      1265571.            134512.              24.74                       111.14                    4.94
   5         79054.        76316.      1781216.            221897.              27.96                        84.37                    5.70
   6         71438.        68456.      1914334.            259521.              28.33                        62.72                    5.15
   7        140894.       135273.      2986556.            430589.              27.03                        95.39                   10.16
   8        223283.       212685.      6134127.            741390.              24.35                        67.25                   16.11
U.S.       1386309.      1323897.     25975376.           3177332.              25.74                        89.96                  100.00
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Continued

Appendix table 3--Examples of program statements--Continued

PROJECTED REGIONAL SUGARBEET STATISTICS
YEAR-- 1979
NY SPOT RAW (CENTS/LB.)-- 13.20

REGION	PLANTED ACRES	HARV. ACRES	BEET PROD. (TONS)	SUGAR PROD (TONS)	GROWER PR. FOR BEETS ($/TON)	PL. ACR. AS 1976	PCT. OF U.S.
1	112989.	104793.	2170442.	234566.	23.24	84.95	9.00
2	383853.	380454.	4711963.	486797.	22.16	95.01	30.59
3	278042.	257534.	4708134.	633112.	27.34	108.99	22.16
4	64725.	58750.	1215848.	128695.	23.73	105.07	5.16
5	64852.	62316.	1666334.	211975.	26.85	69.21	5.17
6	38829.	38846.	1629138.	225142.	27.18	34.09	3.09
7	137276.	131867.	2830224.	417273.	25.97	92.94	10.94
8	174268.	164886.	5309540.	635063.	23.48	52.49	13.89
U.S.	1254834.	1199446.	24241616.	2972619.	24.74	81.43	100.00

PROJECTED REGIONAL SUGARBEET STATISTICS
YEAR-- 1980
NY SPOT RAW (CENTS/LB.)-- 15.40

REGION	PLANTED ACRES	HARV. ACRES	BEET PROD. (TONS)	SUGAR PROD (TONS)	GROWER PR. FOR BEETS ($/TON)	PL. ACR. AS 1976	PCT. OF U.S.
1	112611.	104426.	2196680.	236834.	26.49	84.67	9.09
2	389879.	386497.	4820701.	498136.	25.01	96.50	31.48
3	286389.	265100.	4867539.	651688.	31.64	112.27	23.13
4	66672.	60390.	1257251.	133130.	27.42	108.23	5.38
5	57204.	54776.	1618953.	207967.	30.93	61.05	4.62
6	5542.	8623.	1337365.	189994.	31.39	4.87	0.45
7	144081.	138274.	3015997.	439330.	29.88	97.55	11.63
8	175998.	166573.	5436720.	648657.	26.65	53.01	14.21
U.S.	1238375.	1184660.	24551200.	3005734.	28.28	80.36	100.00